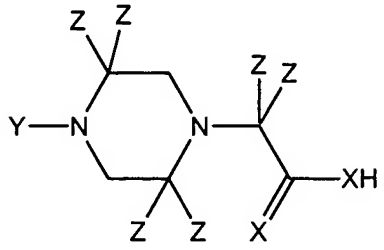
Claims:

I(We) claim:

1. An isotopically enriched N-substituted piperazine acetic acid compound of the formula:



, or a salt thereof, comprising one or more heavy atom isotopes, wherein;

X is O or S;

Y is a straight chain or branched C1-C6 alkyl group or a straight chain or branched C1-C6 alkyl ether group wherein the carbon atoms of the alkyl group or alkyl ether group each independently comprise linked hydrogen, deuterium or fluorine atoms;

each Z is independently hydrogen, deuterium, fluorine, chlorine, bromine, iodine, an amino acid side chain, a straight chain or branched C1-C6 alkyl group that may optionally contain a substituted or unsubstituted aryl group wherein the carbon atoms of the alkyl and aryl groups each independently comprise linked hydrogen, deuterium or fluorine atoms, a straight chain or branched C1-C6 alkyl ether group that may optionally contain a substituted or unsubstituted aryl group wherein the carbon atoms of the alkyl and aryl groups each independently comprise linked hydrogen, deuterium or fluorine atoms or a straight chain or branched C1-C6 alkoxy group that may optionally contain a substituted or unsubstituted aryl group wherein the carbon atoms of the alkyl and aryl groups each independently comprise linked hydrogen, deuterium or fluorine atoms.

2. The compound of claim 1, wherein the N-substituted piperazine acetic acid is isotopically enriched with two or more heavy atom isotopes.

3. The compound of claim 1, wherein the N-substituted piperazine acetic acid is isotopically enriched with three or more heavy atom isotopes.

4. The compound of claim 1, wherein the N-substituted piperazine acetic acid is isotopically enriched with four or more heavy atom isotopes.

5. The compound of claim 1, wherein the heavy atom isotopes are each independently ^{18}O, ^{15}N or ^{13}C, but not deuterium.

6. The compound of claim 1, wherein each Z is independently hydrogen, fluorine, chlorine, bromine or iodine.

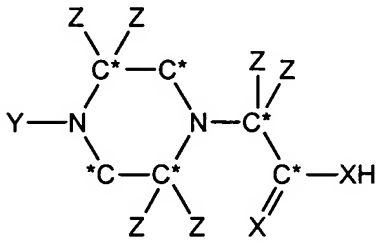
7. The compound of claim 1, wherein each Z is independently hydrogen, methyl or methoxy.

8. The compound of claim 1, wherein Y is methyl, ethyl, *n*-propyl, isopropyl, *n*-butyl, isobutyl, *sec*-butyl or *tert*-butyl.

9. The compound of claim 1, wherein X is ^{16}O or ^{18}O.

10. The compound of claim 1, wherein each nitrogen atom of the piperazine ring is independently ^{14}N or ^{15}N.

11. The compound of claim 1 of the formula:



wherein

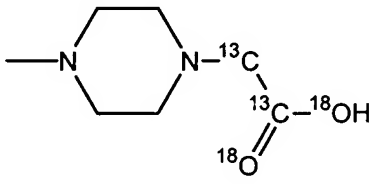
each C* is independently ^{12}C or ^{13}C;

X is O or S;

Y is a straight chain or branched C1-C6 alkyl group or a straight chain or branched C1-C6 alkyl ether group wherein the carbon atoms of the alkyl group or alkyl ether group each independently comprise linked hydrogen, deuterium or fluorine atoms;

each Z is independently hydrogen, deuterium, fluorine, chlorine, bromine, iodine, an amino acid side chain, a straight chain or branched C1-C6 alkyl group that may optionally contain a substituted or unsubstituted aryl group wherein the carbon atoms of the alkyl and aryl groups each independently comprise linked hydrogen, deuterium or fluorine atoms, a straight chain or branched C1-C6 alkyl ether group that may optionally contain a substituted or unsubstituted aryl group wherein the carbon atoms of the alkyl and aryl groups each independently comprise linked hydrogen, deuterium or fluorine atoms or a straight chain or branched C1-C6 alkoxy group that may optionally contain a substituted or unsubstituted aryl group wherein the carbon atoms of the alkyl and aryl groups each independently comprise linked hydrogen, deuterium or fluorine atoms.

12. The compound of claim 1 of the formula: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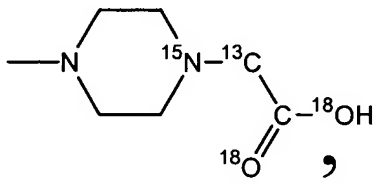
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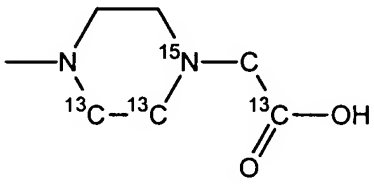
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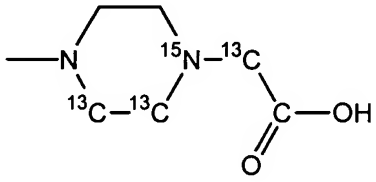
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13. The compound of claim 12, wherein the compound is a zwitterion, mono-TFA salt, a mono-HCl salt, a bis-TFA salt or a bis-HCl salt.

14. The compound of claim 12, wherein each incorporated heavy atom isotope is present in at least 80 percent isotopic purity.

15. The compound of claim 12, wherein each incorporated heavy atom isotope is present in at least 93 percent isotopic purity.

16. The compound of claim 12, wherein each incorporated heavy atom isotope is present in at least 96 percent isotopic purity.

17. The compound of claim 1, wherein the N-substituted piperazine acetic acid is a mono-TFA salt, a mono-HCl salt, a bis-HCl salt or a bis-TFA salt.

18. The compound of claim 1, wherein each incorporated heavy atom isotope is present in at least 80 percent isotopic purity.

19. The compound of claim 1, wherein each incorporated heavy atom isotope is present in at least 93 percent isotopic purity.

20. The compound of claim 1, wherein each incorporated heavy atom isotope is present in at least 96 percent isotopic purity.

21. The compound of claim 12, wherein the compound is a carboxylate anion.

22. The compound of claim 1, wherein the compound is a carboxylate anion.